

CLAIMS

Thus, having described the systems and methods for identifying solder joint defects, I claim the following:

1 1. A method for adapting test thresholds, comprising the following steps:
2 acquiring location information for a plurality of solder joints on a printed-circuit
3 device;
4 obtaining information indicative of the variation in distance between a mounting
5 surface of the printed-circuit device and a printed-circuit board;
6 recording a measurement of a physical property of a plurality of solder joints used to
7 couple the printed-circuit device to the printed-circuit board;
8 estimating a range of acceptable measurements for respective solder joints responsive
9 to variation in distance between the mounting surface of the printed-circuit device and the
10 printed-circuit board; and
11 setting at least one threshold responsive to the range.

1 2. The method of claim 1, wherein the step of acquiring location information
2 comprises an investigation of an array package.

1 3. The method of claim 1, wherein the step of recording comprises a diameter
2 measurement.

1 4. The method of claim 1, wherein the step of recording comprises a height
2 measurement.

1 5. The method of claim 1, wherein the step of recording comprises a volume
2 measurement.

1 6. The method of claim 1, wherein the estimating step comprises performing a
2 statistical analysis on recorded measurements of an identified set of neighbor solder joints.

1 7. The method of claim 6, wherein the statistical analysis comprises calculating
2 the median of the recorded measurements of the identified set of neighbor solder joints.

1 8. The method of claim 1, wherein the estimating step comprises formulating a
2 best fit polynomial equation using the recorded measurements of a plurality of solder joints.

1 9. The method of claim 1, wherein the estimating step comprises applying the
2 recorded measurements of a plurality of solder joints in a Fourier analysis.

1 10. The method of claim 9, wherein the Fourier analysis comprises the application
2 of a high-frequency filter on the recorded measurements of an identified set of solder joints
3 distributed across the surface of the device.

1 11. The method of claim 1, wherein the step of setting further comprises:
2 comparing the expected value with the recorded measurement to generate an error
3 value for the plurality of solder joints on the printed-circuit device; and
4 performing an outlier analysis on the plurality of error values to establish at least one
5 threshold value.

1 12. The method of claim 11, wherein the step of comparing the expected value
2 with the recorded measurement comprises a mathematical combination of the expected value
3 with the recorded measurement.

1 13. The method of claim 12, wherein the mathematical combination comprises a
2 difference.

1 14. A method for identifying solder joint defects, comprising the steps of:
2 recording a measurement associated with a plurality of solder joints on a printed-
3 circuit device;
4 estimating an expected value for the plurality of solder joints that accounts for
5 acceptable variance in the distance between the mounting surfaces of a printed-circuit device
6 and a printed-circuit board coupled by the solder joints;
7 comparing the recorded measurement with the expected value for the plurality of
8 solder joints to generate a respective error value; and
9 identifying defective solder joints by applying an error value outlier analysis to the
10 plurality of error values.

1 15. The method of claim 14, wherein the step of recording comprises an
2 investigation of an array package.

1 16. The method of claim 14, wherein the step of recording comprises a diameter
2 measurement.

1 17. The method of claim 14, wherein the step of estimating an expected value for
2 the plurality of solder joints comprises performing a statistical analysis on the recorded
3 measurements of a set of neighboring solder joints.

1 18. The method of claim 14, wherein the step of estimating an expected value for
2 the plurality of solder joints comprises performing a statistical analysis on the recorded
3 measurements of a set of solder joints equidistant from the centroid of the printed-circuit
4 device.

1 19. The method of claim 17, wherein the statistical analysis comprises calculating
2 the median of the recorded measurements of the identified set of neighboring solder joints.

1 20. The method of claim 14, wherein the step of estimating an expected value for
2 respective solder joints comprises formulating a best fit polynomial equation using the
3 recorded measurements of the plurality of solder joints.

1 21. The method of claim 14, wherein the step of estimating an expected value for
2 the plurality of solder joints comprises applying the recorded measurements of a plurality of
3 solder joints in a Fourier analysis.

1 22. The method of claim 21, wherein the Fourier analysis comprises the
2 application of a high-frequency filter on the recorded measurements of a plurality of solder
3 joints.

1 23. The method of claim 14, wherein the step of comparing the expected value
2 with the recorded measurement comprises a mathematical combination of the expected value
with the respective recorded measurement.

1 24. The method of claim 23, wherein the mathematical combination comprises the
difference of the expected value with the respective recorded measurement.

1 25. The method of claim 23, wherein the step of identifying defective solder joints
comprises a box plot analysis responsive to the plurality of error values.

1 26. An improved solder-joint inspection system, comprising:
2 means for measuring at least one characteristic of a plurality of solder joints on a
3 printed-circuit device;
4 means for computing an expected value for the measured characteristic for each of the
5 plurality of solder joints that varies as a function of distance between the mounting surface of
6 the printed-circuit device and a printed-circuit board; and
7 means for formulating an error value as a function of the measured characteristic and
8 the expected value for the plurality of solder joints.

1 27. The system of claim 26, further comprising:
2 means for analyzing the plurality of error values to identify solder joint defects.

1 28. The system of claim 27, wherein the means for analyzing comprises a box
2 plot.

1 29. The system of claim 26, wherein the means for measuring comprises an
2 automated X-ray inspection system.

1 30. The system of claim 26, wherein the means for measuring comprises an optical
2 inspection system.

1 31. A solder-joint defect analysis detection program stored on a computer-readable
2 medium, comprising:

3 logic configured to record at least one characteristic of a plurality of solder joints on a
4 printed-circuit device;

5 logic configured to determine an expected value for the at least one characteristic for
6 the plurality of solder joints responsive to low frequency change in a solder joint
7 characteristics across the device;

8 logic configured to generate an error value from a mathematical combination of the
9 expected value and the recorded characteristic for the plurality of solder joints on the printed-
10 circuit device; and

11 logic configured to identify error value outliers.

12 32. The program of claim 31, wherein the logic configured to record records at
2 least one characteristic of a solder joint associated with an array package.

1 33. The program of claim 31, wherein the logic configured to determine an
2 expected value reflects a statistical analysis of the recorded characteristic.

1 34. The program of claim 31, wherein the statistical analysis comprises calculating
2 a median.

1 35. The program of claim 31, wherein the logic configured to generate an error
2 value calculates the difference of the recorded characteristic and the expected value.

1 36. The program of claim 31, wherein the logic configured to identify error value
2 outliers comprises a box plot analysis.

1 37. The program of claim 36, wherein the box plot analysis identifies error values
2 that exceed a constant multiple of the interquartile range for the error values above a constant
3 percentage of the error value data range.

1 38. The method of claim 1, wherein the step of obtaining comprises measuring the
2 distance between a mounting surface of the printed-circuit device and a printed-circuit at a
3 plurality of locations.

1 39. The method of claim 1, wherein the step of acquiring location information
2 comprises an investigation of a quad flat pack package.

1 40. The method of claim 1, wherein the step of recording comprises a two-
dimensional measurement.

1 41. The method of claim 1, wherein the step of recording comprises a three-
dimensional measurement.

1 42. The method of claim 14, wherein the step of recording comprises an
investigation of a quad flat pack package.

1 43. The method of claim 14, wherein the step of recording comprises a one-
dimensional measurement.

1 44. The method of claim 14, wherein the step of recording comprises a two-
dimensional measurement.

1 45. The method of claim 14, wherein the step of recording comprises a three-
dimensional measurement.

1 46. The method of claim 1, wherein the step of estimating an expected value for a
2 plurality of solder joints comprises performing a statistical analysis on the recorded
3 measurements of a set of solder joints equidistant from the centroid of the printed-circuit
4 device.

1 47. The program of claim 32, wherein the logic configured to estimate, estimates
2 responsive to the distance between the mounting surface of a printed-circuit device and a
3 printed-circuit board.

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